

# international journal of electrical engineering education

**Volume 9**

**Issues 1-6**

**1971**

**Consultant Editors**

Professor L. M. Wedepohl  
Dr. Colin Adamson

**Editor**

Michael G. Hartley

**Assistant Editor**

R. M. Kay

**Books Review Editors**

David H. Green  
Harold C. A. Hankins  
Harry D. McKell  
Brian Stott

U. of ILL. LIBRARY

JUL 12 1973

CHICAGO CIRCLE

The *International Journal of Electrical Engineering Education* is published for the Department of Electrical Engineering and Electronics of the University of Manchester Institute of Science and Technology, Manchester, M60 1QD England, by Wynn Williams (Publishers) Ltd., Wrexham. Publication is bimonthly.

The University of Manchester Institute of Science and Technology

**President**

Lord Stokes of Leyland

**Principal**

Rt Hon the Lord Bowden of Chesterfield

**Dean**

Professor T. K. Ross

**Registrar and Secretary to Council**

J. Burgess

**Bursar**

B. S. Stevenson



# editorial advisory panel

## Chairman

Professor C. Gregoire

*Département d'Electricité, Faculté Polytechnique de Mons, Belgium*

**Canada**

Professor J. Reeve

*Electrical Engineering Department, University of Waterloo, Ontario, Canada*

**Egypt**

Dr. S. I. Saleeb

*Scientific Computation Centre, Cairo University, Giza, Egypt*

**France**

Professor N. J. Felici,

*University of Grenoble, Laboratoire, d'Électrostatique et de Physique de Métal, Grenoble,*

*France*

**India**

Professor T. N. Saha

*Indian Institute of Technology, Kharagpur, India*

**Iraq**

Dr. N. K. Wafi

*College of Engineering, Baghdad University, Iraq*

**Italy**

Professor A. L. Frisiani,

*Istituto di Elettrotecnica, Facoltà di Ingegneria, Università di Genova, Genoa 67, Italy*

**Singapore**

Professor J. W. Y. Chen

*Electrical and Electronics Eng'g Dept., Faculty of Engineering, University of Singapore*

**Spain**

Professor Carlos Jordana

*Escuela Técnica Superior de Ingenieros Industriales, Universidad de Navarra, San Sebastian,*

*Spain*

**Sweden**

Professor Sune Rusck

*Electric Power Systems Eng'g., Royal Inst. of Technology, Stockholm, Sweden*

**Syria**

Dr. S. M. El-Sobki

*Unesco Advisor, Technological Institute of Damascus, Syria*

**Turkey**

Dr. Ayhan Tureli

*Electrical Eng'g. Dept., Technical University of Ankara, Turkey*

**United Kingdom**

Professor P. Hammond,

*Electrical Engineering Department, The University, Southampton*

J. Heywood Esq.,

*Industrial Studies Unit, Faculty of Eng'g. Science, University of Liverpool*

A. C. Normington Esq.,

*Head of Electrical Engineering Department, Bolton Institute of Technology, Bolton, Lancs.*

**United States of America**

Professor T. J. Higgins,

*Electrical Engineering Department, University of Wisconsin, Madison 6, Wisconsin, U.S.A.*

Professor J. Willis,

*Engineering Department, University of California at Los Angeles, California, U.S.A.*

**West Germany**

Herr R. Uhrig,

*6901 Altenbach, Kreis Heidelberg, Blumenstraße 20, Fed. Republic of Germany*

**Yugoslavia**

Professor K. Prelec,

*Faculty of Science, University of Zagreb, Yugoslavia*



# notes to contributors

For the benefit of readers and potential contributors, the main divisions of the *Journal's* contribution to electrical engineering education are summarized below. This list is not intended to be exhaustive.

(1) Articles which describe methods for the presentation of new topics in electrical engineering or fresh aspects of the teaching of traditional subject matter. The level of these articles will vary considerably. Some will cater for the needs of the Technical Colleges, others for Universities, while some will be directed towards teaching at the post-graduate level. While English is to be the preferred language, articles in other languages will be accepted. In any event a brief abstract in English will be required. Abstracts of papers will also be given in French, German and Spanish. While authors will receive no payment for their contributions, they will be provided with a number of reprints.

(2) Accounts of laboratory experiments. These should describe new techniques for dealing with traditional subjects, or alternatively should illustrate new or expanding branches of electrical engineering. The accounts may be presented in one of two ways.

(a) A complete, though concise, description, sufficient to enable the experiment to be set up in any teaching laboratory.

(b) A brief 'Abstract' to be included in the *Journal*, accompanied by a complete Report not intended for publication.

The *Journal* provides a service whereby those interested in particular reports which have appeared in the *Bulletin* or the *Journal* may borrow copies of the complete report. This is more appropriate, for example, when the number of diagrams makes it impossible to adopt procedure (a). This service is free to subscribers.

(3) Articles which discuss the object, content and organization of part-time, sandwich, undergraduate, and graduate courses in technical colleges and universities in various parts of the world, also material relating to new features in industrial-university relationships, seminars, training schemes and graduate apprentice courses. Such articles should not be merely factual accounts, but should attempt to justify and assess such courses and events so that others are able to profit from the experience reported.

The pace of development in electrical engineering education, in common with other aspects of technical and scientific education, is now very rapid. Not all of the interesting experiments and advances arise directly as the result of university and college activities. Where there has been industrial or governmental initiative it is hoped to encourage publication of the details.

(4) Articles which describe research, *provided that the topic has direct relevance to education at the undergraduate or graduate level*. There are many examples where successful research projects have led to new laboratory teaching experiments. This is particularly applicable where special apparatus and laboratories have been established in universities and other research institutes.

(5) Short accounts of advanced and graduate lecture courses, particularly where these include sets of lecture notes that can be borrowed as in (2b).

(6) Reports of educational conferences. The Editors propose to report on the proceedings of major educational conferences wherever they are taking place throughout the world through the International Advisory Panel. One or other of the Editors will probably be present at the more important European meetings.

(7) Book Reviews. It is proposed to provide comprehensive and searching book reviews. The aim will be to assist materially those who are anxious to assess the desirability or otherwise of a particular volume to their aspect of education. Bimonthly publication will ensure prompt review of books. Publishing houses are invited to submit books for review.

Staff members lecturing for the first time on a new topic often find a need for guidance as to the most appropriate book in a particular field. To assist them it is hoped to encourage publishers to submit publications on various selected topics to the Editors so that survey reviews may be provided in these special fields.

(8) Letters to the Editor. The Editors welcome correspondence connected with articles in the *Journal* and related topics.



**volume 9**

1 *Editorial*

- number 2

- 4

## number 3

- 163 *Editorial*
- 165 *Simple Series applicable to Cascaded Identical Sections* by J. W. Reddie
- 173 *An Approximation of All-Pole Transfer Functions and Application to Distributed RC Networks* by S. C. Dutta Roy
- 181 *The Classification of Educational Objectives for Undergraduate Course, with particular reference to Electrostatics* by B. Bolton
- 193 *Computer Education and the Computer Education Group* by H. L. W. Jackson
- 199 *A constant-impedance phase-shifter* by T. Palmer
- 205 *The Reactive Energy Theorem of the Electro-Mechanical Energy Conversion* by Vasile N. Nedelcu
- 215 *A Note on the Measure of Self-Information* by N. U. Ahmed and S. G. S. Shiva
- 217 *A Digital Tachometer using a Commercial Counter* by C. G. Streatfield
- 221 *Abstracts of Articles—English/French/German/Spanish*
- 229 *Review of Reviews*
- 231 *Book Reviews*
- 240 *Journals Received*

## number 4

- 243 *Editorial*
- 245 *Stability of Linear Systems with Multiple Variables* by H. H. Hwang
- 259 *The A.C. Machine Commutator* by J. E. Beresford
- 265 *Energy Conversion, Transfer and Storage at 4.2°K* by R. S. Ramshaw
- 276 *The Faraday Machines Laboratory* by Eric T. B. Gross and Claude M. Summers
- 289 *University Training for Electrical Engineers in Developing Countries* by D. J. Harris
- 297 *Power Angle Diagrams for Synchronous Machines with Automatic Voltage Regulator* by T. N. Saha
- 306 *Abstracts of Articles—English/French/German/Spanish*
- 313 *Review of Reviews*
- 316 *Book Reviews*
- 320 *Journals Received*



## number 5

- 323 *Editorial*
- 324 *Writing a Higher Degree Thesis* by B. Adkins
- 327 *Combined Power Circle Diagram for Transmission Line Calculators* by G. Thomas
- 337 *Computer Control with Elliott 803B*
- 341 *Measurement of Electrostatic Potential* by G. J. Berg
- 345 *A Teaching Experiment using a form of Programming* by J. Hiller
- 354 *New Derivation of the Transformation Matrices in Generalised Machine Theory* by J. L. Williams
- 360 *Balanced Capacitor Excited Braking of an Induction Machine* by R. Perryman
- 368 *Converter-Reverter Chart for Impedance Calculations* by M. C. Hatley
- 370 *A Demonstration of Transistor Circuit Design* by G. S. Hobson
- 374 *Laboratory Version of the Notch Filter using a section of Distributed Resistance-Capacitance 'Transmission Line'* by J. Watkins
- 381 *Abstracts of Articles—English/French/German/Spanish*
- 390 *Review of Reviews*
- 392 *Book Reviews*

## number 6

- 403 *Editorial*
- 404 *A Model to Demonstrate the Properties of Electric Distribution Functions* by G. S. Hobson
- 411 *Analytical Root Locus Design Study of Servomechanisms with Inertial Damping* by Henry M. Power
- 425 *The Measurement of Magnetic Flux by Ballistic Galvanometer* by D. S. Thompson
- 430 *On the Equivalence of Negative Resistance and Feedback Oscillators* by R. W. V. Barker
- 433 *The Indefinite Laplace Transform Technique and Applications to the Analysis of Initial and Boundary Value Problems* by E. Bahar
- 444 *An Experiment in Screening and Earthing Techniques* by B. A. Gregory
- 449 *Synchronous Machine Sequence Inductances and Transformation Theory* by W. J. Bonwick
- 463 *Abstracts of Articles—English/French/German/Spanish*
- 471 *Letters to Editor*
- 472 *Journals Received*
- 473 *Review of Reviews*
- 474 *Book Reviews*

# subject index

# volume 9

## Abstracts

English 58, 141, 221, 306, 381, 463  
French 60, 142, 223, 307, 383, 465  
German 62, 144, 225, 309, 385, 467  
Spanish 64, 145, 227, 311, 387, 469

**AC Machine Commutator** 259

## All-Pole Transfer Functions

application to R.C. networks 173

## Automatic Voltage Regulator

with synchronous machines 297

## Ballistic Galvanometer

measuring magnetic flux 425

## Book Reviews

67, 148, 231, 316, 392, 474

**Braking, Induction Machine** 360

## Cascade Coder

mechanical demonstration model 43

**Cascaded Identical Sections** 165

**Commutator, AC Machine** 259

## Computer Control

and sampled data systems 3, 83  
with Elliott 803 B 337

**Computer Education** 193

## Computer Science

as a new discipline 130

**Constant-impedance Phase Shifter** 199

## Converter-Reverter Chart

for impedance calculations 368

## Cross Field Machines

equivalent circuit 129

## Data Systems

and computer control 3, 83

## Demonstration

cascade coder 43  
charge storage in diodes 110  
transistor circuit design 370  
wave propagation in periodic lattices 90

## Developing Countries

university training for elec. engrs. 289

## Digital Tachometer

with commercial counter 217

## Distributed RC Networks

all-pole transfer functions 173

## Double-fed Machine

increase of dynamic stability 17

## Dynamic Stability, Increase of

in doubly-fed machine 17

**Earthing, Screening-expt.** 444

## Editorials

1, 163, 243, 323, 403

## Electrical Engineering Education

computer education 193  
educational objectives for u/g course 181  
final year projects 136  
graduate and industry 120  
in developing countries 289  
seventy years of elec. machines 40  
undergraduate practical work 49  
writing a higher degree thesis 324

## Electronic Velocity

distribution functions, model 404

## Electronics Course

first year, practical 49

## Electrostatic Potential

measurement 341

**Electrostatics in U/G Course** 181

**Elliott 803 B, as Control** 337



**Energy Conversion**

at 4.2°K 265

reactive energy theorem 205

**Equivalence**

Neg. resistance, feedback osc's 430

**Equivalent Circuit**

for cross field machines 129

**Experiment**

screening, earthing technique 444

**Faraday Machines Laboratory** 276**Fourier Transforms**

in transmission-line analysis 32

**Generalised Machine Theory**

transformation matrices 354

**Graduate and Industry** 120**Higher Degree Thesis** 324**Identical Sections, Cascaded**

simple series 165

**Impedance Calculations**

converter-reverter chart 368

**Induction Machine Braking**

balanced capacitor excited 360

**Insulators**

potential distribution across 96

**Journals Received**

78, 159, 240, 320, 472

**Laboratory**

Faraday machines 276

version of notch filter 374

**Laplace Transform**

technique, application 433

**Letters to the Editor**

54, 140, 471

**Linear Systems**

stability, with multiple variables 245

**Machine Equations and Networks** 105**Magnetic Flux**

measurement by ballistic galvo. 425

**Magnetic Materials**

models to demonstrate properties 99

**Measurement**

electrostatic potential 341

magnetic flux 425

self-information 215

**Mechanical Demonstration Model**

of cascade coder 43

**Models, to demonstrate**

electronic velocity dist'n functions 404

magnetic properties 99

**Negative Resistance**

equiv. to feedback osc. 430

**Network**

and machine equations 105

**Notch Filter**

laboratory version 374

**Periodic Lattices**

wave propagation 90

**Phase-shifter**

constant impedance 199

**Phasors and Complexors**

for network and machine equations 105

**Potential Distribution**

across insulators 96

**Power Angle Diagrams**

for synchronous machines 297

**Power Circle Diagram**

transmission line calculations 327



<b>Practical Work</b>	
undergraduate (1st year)	
<b>Programming</b>	
in teaching experiment	345
<b>Projects, Final Year</b>	136
<b>Reactive Energy Theorem</b>	
electro-mech'l energy conversion	205
<b>Review of Reviews</b>	
77, 156, 229, 313, 390, 473	
<b>Root Locus Study</b>	
servomechanisms, damped	411
<b>Screening, Earthing Expt.</b>	444
<b>Self-Information, Measure of</b>	215
<b>Servomechanisms, Damped</b>	
root locus study	411
<b>Seventy Years</b>	
of electrical machines	40
<b>Stability of Linear Systems</b>	
with multiple variables	245
<b>Synchronous Machines</b>	
power angle diagrams	297
seq. inductances, transf'n theory	449
<b>Tachometer, Digital</b>	
with commercial counter	217
<b>Teaching Experiment</b>	
form of programming	345
<b>Transformation Matrices</b>	
in generalised machine theory	354
<b>Transform, Indefinite Laplace</b>	
technique and applications	433
<b>Transistor Circuit Design</b>	
demonstration	370
<b>Transmission-line</b>	
analysis—Fourier transforms	32
calculations—circle diagram	327
laboratory version of notch filter	374
<b>Wave Propagation</b>	
in periodic lattices	90

*Book reviews given in the order in which they appear in the various issues of the Journal*

## Number 1

Electrical Installation Work

by R. A. Mee

Principles of Electricity in S.I. Units

by A. Morley and E. Hughes

Telecommunications

by W. Fraser

Dictionary of Telecommunications

by R. A. Bones

The Physics of Microwave Propagation

by Donald C. Livingstone

Filter Systems and Design: Electrical  
Microwave and Digital

by Yale Jay Lubkin

Electromagnetism and Quantum Theory

by D. M. Grimes

Introduction to Semiconductor Devices

by M. J. Morant

Integrated Circuit Electronics

by Nick Holonyak

Introduction to Logic Circuit Theory

by I. Aleksander

Computer Logic: A Laboratory Workbook

by H. V. Malmstadt and C. G. Enke

Computer-Aided Design Techniques

by E. Wolfendale

Analog and Hybrid Computing

by D. E. Hyndman

Fundamentals of Servomechanisms

by Ruth V. Buckley

Theory of Hierarchical, Multilevel Systems

by M. D. Mesarovic, D. Macko and  
Y. Takahara

A review of Programming Languages

by Bernard A. Galler and Alan J. Perlis

A Guide to COBOL Programming

by Daniel D. McCracken and  
Umberto Garbassi

Physical Applications of Vectors  
and Tensors

by H. Teichmann

Part 2 Mechanical Engineering (503)

by D. W. G. Hall, H. Higgins,  
J. K. Millington and T. E. Savage

Rings, Modules and Linear Algebra

by B. Hartley and T. O. Hawkes

## Number 2

Nonlinear Stochastic Control Systems

by A. T. Fuller

Foundation of Wireless and Electronics

by M. G. Scroggie

Dynamic Systems Models

by A. G. J. MacFarlane

Design Methods

by J. Christopher Jones

Electric Charge & Electric Current.  
Resistance and Ohm's law. Capacitance  
and Capacitors. Introduction to AC  
Machines

Educational Systems Limited

Logic Design of Digital Systems

by Donald L. Dietmeyer

Automobile Electrical Equipment

by Young & Griffiths

MHD Power Generation: Engineering  
Aspects

by G. J. Womack

Electromagnetics and Machines

by R. E. Steven

Optimisation and Probability in Systems  
Engineering

by John G. Rau



### Number 3

Introductory Quantum Mechanics for the Solid State  
by Richard L. Longini

Optimisation Theory for Large Systems  
by Leon S. Lasdon

Formulation and Optimisation of Mathematical Models  
by C. L. Smith, R. W. Pike and P. W. Murrill

Transmission of Information by Orthogonal Functions  
by Henning F. Harmuth

Measure Electriques—Courant continu, courant alternatif, basse fréquence  
par P. Jacobs et V. Jadin

Practical Matrix Algebra  
by M. A. R. Gurston

Graded Examples in Mathematics  
E. G. Shalders

Guided Examples in Electrical Engineering  
by C. G. Parton

Lectures on the Electrical Properties of Materials  
by L. Solymar and D. Walsh

Active and Nonlinear Wave Propagation in Electronics  
by Alwyn Scott

Complex Variables  
by N. Levinson and R. M. Redheffer

Stochastic Processes and Filtering Theory  
by Andrew H. Jazwinski

### Number 4

Electric Energy Systems Theory: An Introduction  
by O. I. Elgerd

Electron Optics  
by O. Klemperer and M. E. Barrett

Basic Engineering Craft Studies 500: General 01  
by P. H. M. Bourbousson and R. Ashworth

Digital Networks and Computer Systems  
by Taylor L. Booth

Computers in the Classroom  
by J. B. Margolin and M. R. Misch

### Number 5

Computer Programming in ALGOL  
by J. D. Earnshaw and W. A. R. Blackford

Thorium Fuel Cycle  
(H.M. Stationery Office for IAEA)

Tellegen's Theorem and Electrical Networks  
by Paul Penfield, Robert Spence and S. Duiker

Alternating Currents  
by J. M. Gregory

Nuclear Science  
by P. J. Grant

Introduction to Thermodynamics—Classical and Statistical  
by Richard E. Sonntage, Gordon J. Van Wylen

Electronic Integrated Circuits and Systems  
by Franklin C. Fitchen

Telecontrol  
by Gunther Swoboda

Diakoptics and Networks  
by H. H. Happ

Critical Path Analysis in Practice  
by Gail Thornley

Basic Principles of Electronics, Vol. 2  
Semiconductors  
by J. Jenkins and W. H. Jarvis

Fundamentals of Gaseous Ionisation and Plasma Electronics  
by Essam Nasser

### Number 6

Modern Electronic Materials  
by J. Watkins

Exercises in Graphic Communication  
by R. Thomson

An Introduction to Applied Probability and Random Processes  
by John B. Thomas

Theory of Resistive Mixers  
by A. A. M. Saleh

Engineering Mathematics Handbook  
by Jan J. Tuma



Fourier Series and Partial Differential  
Equations

by I. M. Calus, J. A. Fairley

Calculations in Fundamental Physics  
Vols. 1 & 2

by Trevor Heddle

Bibliography of British Technological  
Education and Training

by John Heywood

Computers in Transport Planning  
and Operation

by Anthony Wren

Basic Mathematical Formulae for Student  
Engineers and Scientists

by R. H. Clarke

The Computer in Art

by Jasia Reichardt

Time-domain Synthesis of Linear Networks  
by K. L. Su

Electronics: Principles and Techniques

by S. Ramabhadran

## author index

Adkins, B. 324  
Ahmed, N. V. 215  
Aitken, G. J. M. 32  
Alston, I. A. 17  
Atchison, W. F. 130  
  
Bahar, E. 433  
Bailey, A. G. 49  
Barker, R. W. J. 430  
Barnes, L. 136  
Beresford, J. E. 259  
Berg, G. J. 341  
Beynon, J. D. E. 49  
Bolton, B. 181  
Bonwick, W. J. 449  
Bowden, Lord 120  
  
Chalmers, B. J. 40  
  
Gatta, S. R. 55  
Gregory, B. A. 444  
Gross, E. T. B. 276  
  
Hampshire, M. J. 110  
Harris, D. J. 289  
Harris, N. G. 54  
Hartley, M. G. 243, 403  
Hatley, M. C. 368  
Hiller, J. 345  
Hobson, G. S. 90, 99, 370  
Holmes, P. G. 17  
Hwang, H. H. 245  
Indulkar, C. S. 471

## volume 9

Jackson, H. L. W. 193  
  
Kay, R. M. 229, 323, 390  
Kuppuswamy, T. S. 96  
  
McLean, K. J. 129  
  
Nedelcu, V. N. 205  
Niemi, A. 337  
  
O'Kelly, D. 105  
  
Palmer, T. 199  
Perryman, R. 360  
Phillips, V. J. 43  
Power, H. M. 411  
  
Ramshaw, R. S. 265  
Reddie, J. W. 165  
Roy, S. C. Dutta 173  
  
Saha, T. N. 297  
Shiva, S. G. S. 215  
Streatfield, C. G. 217  
Summers, C. M. 276  
Suryanarayanan, N. K. 140  
  
Thiruvengadam, S. 471  
Thomas, G. 327  
Thompson, D. J. 425  
  
Watkins, J. 374  
Willems, J. L. 354  
  
Zakian, V. 3, 83